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The Third Revolution

The American supermarket—a marvel of convenience, efficiency, and plenitude—is the envy of the world. In concept, it seems light years away from the not so distant era dominated by the small specialized store where customer and clerk transacted business over the counter. Since then, food stores have come through two revolutions: self service and the supermarket.

Self service dates from early in this century when food retailer Clarence Saunders broke with tradition and instituted the first turn-style and checkout stand. This approach to merchandising helped pave the way for the second innovation, supermarketing, which took root during the Great Depression. With millions of people unemployed, it was necessary to find ways to cut food prices drastically by lowering operating costs.

The first supermarkets were austere operations. Often housed in abandoned warehouses, they displayed goods on plain board shelves, even in shipping crates. Despite later refinements, their popularity was hampered by a chronic bottle-neck at the meat counter where shoppers had to take a number and await service. But supermarkets won acceptance with the advent of prepackaged fresh meats, an innovation pioneered by ARS marketing researchers. This and other innovations enabled supermarkets to thrive because they lowered store operating costs by serving more customers, and thus held down food prices.

Today supermarkets face rising costs for labor, equipment, and buildings. And as stores carry ever more items, inventory and delivery costs climb, and quality control grows in complexity. Conditions seem ripe for supermarkets to move into a third revolution: the centralization of the food store's processing functions.

Food stores of the future will serve almost entirely to merchandise and check out food items. Little backroom space will be allotted to such functions as storing groceries, preparing produce for sale, or processing meats. These and such functions as pricing and accounting will be moved to central plants equipped and manned to serve several stores.

Centralization will bring economies of scale not otherwise possible. To cite a few examples: automatic checkout, better inventory control through electronic data processing, fuller use of equipment and facilities, and lower delivery costs. These and other advantages of centralization will significantly lower the costs of food retailing. ARS marketing specialists are working to identify and solve the problems of the third revolution, one that will keep filling the cornucopia that is the supermarket.

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COVER: Artist's concept of the Earth Resources Technology Satellite (ERTS–1) in orbit. This is the first United States satellite program devoted exclusively to the study of Earth's natural resources (PN–2809). Photos Courtesy National Aeronautics and Space Administration. Story begins on page 3.

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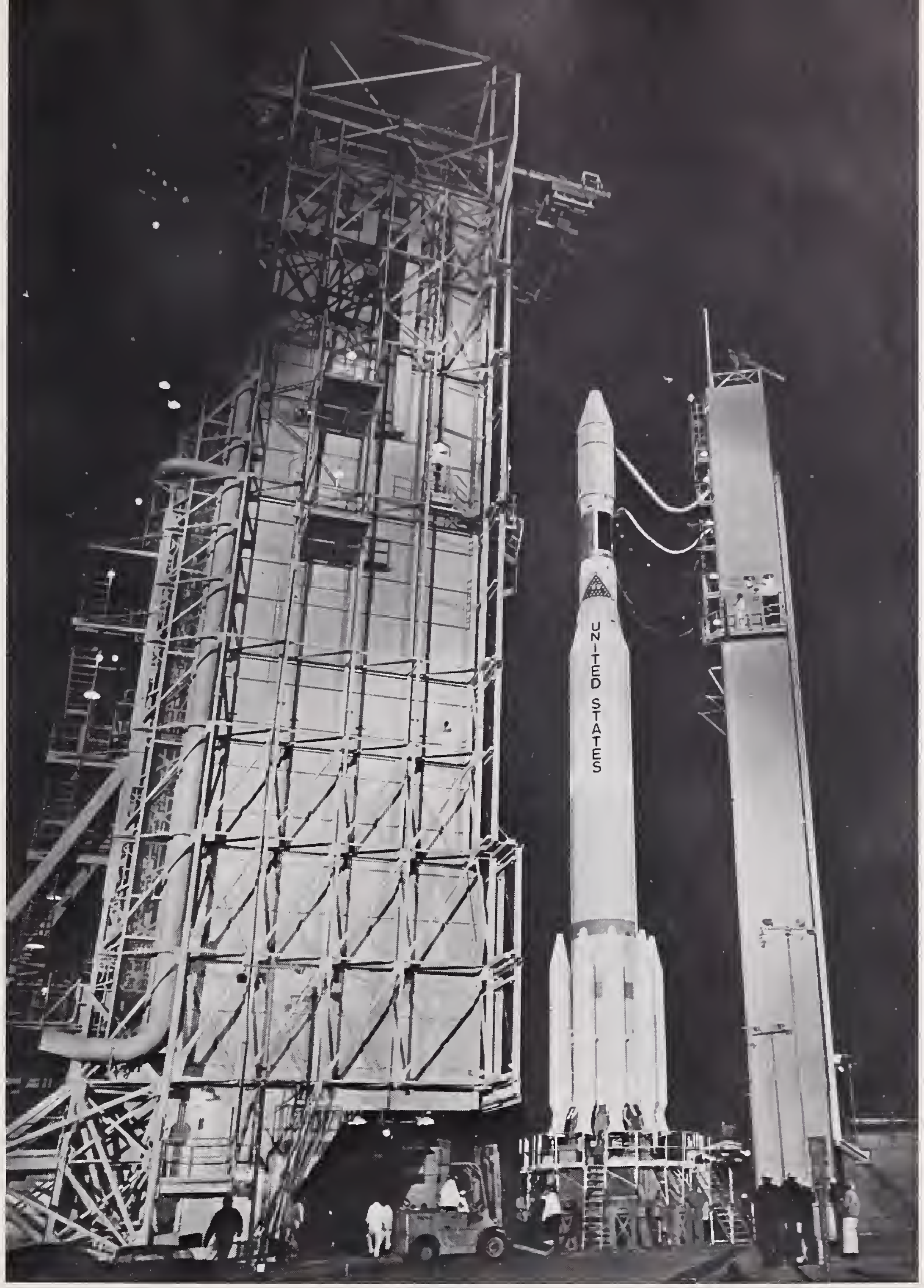


The National Aeronautics and Space Administration's Earth Resources Technology Satellite 1 (ERTS–1) is shown on the launch complex during the final countdown. The ERTS–1 with the Delta 89 booster was launched from the Western Test Range at 11:06 A.M. PDT July 23, 1972, and was placed into a near-polar sun-synchronous orbit (PN–2810).

Earth's Secrets probed from space

EVERY 103 MINUTES, an unmanned butterfly-shaped observatory circles the Earth, scanning it to gather technology that will help agricultural scientists develop better management of plant, soil, and water resources.

This "God's eye" view of Earth is obtained from ERTS–1 (the first Earth Resources Technology Satellite) which was launched from the Western Test Range at Lompoc, Calif., July 23, by the National Aeronautics and Space Administration. The ERTS–2 satellite is scheduled for launch late next year.

The 1,965-pound (891-kilogram) satellite is 8 feet wide by 106 feet high. It not only marks a first step in the merger of space and remote sensing technology to more efficiently manage the Earth's resources, but will also greatly aid in assessing and understanding the changes taking place in our environment.

ERTS–1 carries imaging systems which will provide data that could produce breakthroughs in the efficiency of user-oriented activities in agriculture, forestry, geology, geography, hydrol-

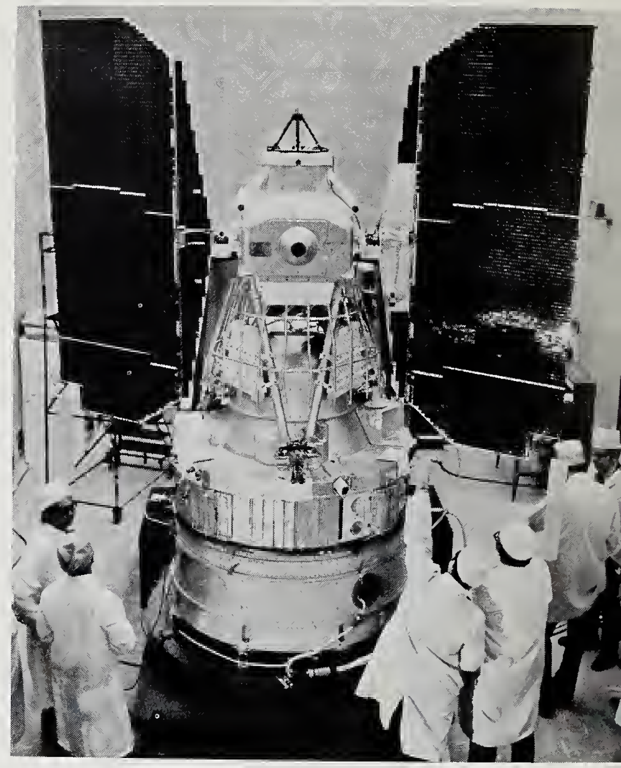
ogy, pollution control, oceanography, meteorology, and ecology.

For a year or longer, three TV cameras aboard ERTS–1 are expected to photograph the earth's surface in black and white. During each 560 statute mile (900 km) high orbit, ERTS–1 views a 113-mile (180 km) strip of Earth running north and south at an angle to the equator. It will provide complete global coverage between 81 degrees north and 81 degrees south latitude. Remote sensing equipment will collect data in the visible and near-infared regions of the electromagnetic spectrum. In addition, a four-band multi-spectral scanner will also sample these wavelengths of light simultaneously. On board also is a data collection system providing the capability to collect, transmit, and disseminate data from remotely or inaccessibly located Western Hemisphere earth-based sensors. Ground-based computers will interpret the resulting patterns.

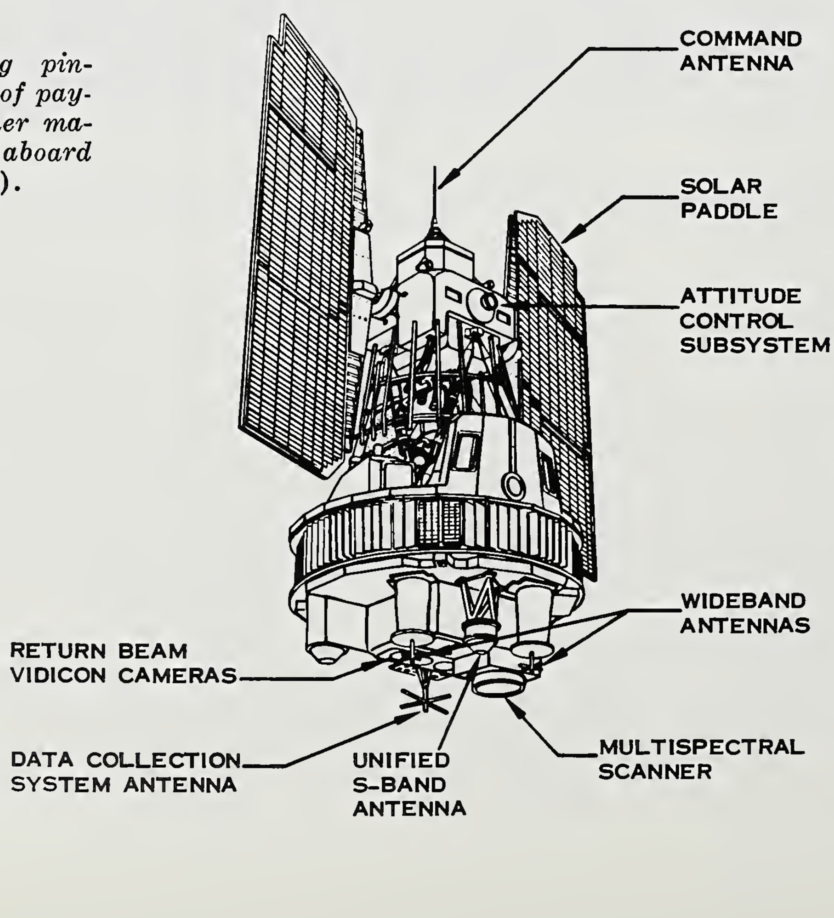
ERTS–1 will gather information on vegetation, soil, and water faster than it can be gathered with aircraft or ground observations. Also, the field of view will be larger, 113 miles on a side or approximately 13,000 square miles (180 km square) per frame. Global coverage will occur every 18 days as the spacecraft travels in its near polar, sun-synchronous orbit. Each day the satellite will make approximately 14 revolutions around the earth. As the earth rotates beneath ERTS–1, the ground coverage will proceed westward until the global coverage of overlapping image swaths is completed in the 18-day period and then repeated. This repetition will permit the seasonal monitoring of crops and natural resources.

Ground observations will still be important for developing remote sensing technology. Each soil condition, plant, and body of water has unique and measurable reflectance and radiation characteristics called "spectral signatures."

ARS scientists began actively identifying spectral signatures more than a decade ago. The work was done in systematic fashion, first in the laboratory where different wavelengths of light from a prism were aimed at leaves. A spectrophotometer measured the amount of light transmitted through the leaves. Then the laboratory findings were confirmed by aiming the instruments at growing crops from 70-foot platforms. Then aircraft at various altitudes were used. At each level, essentially the same task was done, recording the reflectance and emissivity of plants and soils. Studies using aircraft led the way to specifying instrumentation and wavelength intervals needed for experimentation during the Apollo 9 flight.



ERTS–1 spacecraft in flight configuration with solar panels deployed. Design of the observatory is based on the Nimbus meteorological satellites which have returned pictures of the Earth's weather state since 1964 (PN–2812).



This line drawing pinpoints the location of payload items and other major components aboard ERTS–1 (PN–2811).

Four ARS experiments are included in the ERTS–1 scientific program; distinguishing among various kinds of vegetation, detecting insect infestations of crop plants, monitoring the effectiveness of wind erosion control, and using space data in watershed hydrology.

Soil scientist Craig L. Wiegand will study the reflectance patterns of vegetation, soil, and water at Weslaco, Tex., where the ARS remote sensing research operations are centered. Plant leaves yield most of the reflectance from vegetation measured by remote sensors in aircraft and spacecraft. The reflectance produced by vegetation, however, is usually imposed on a soil background. Dr. Wiegand will attempt to learn from space-gathered data if multispectral

Video signals from ERTS–1 Return Beam Vidicon Cameras and Multi-Spectral Scanner will be received by a 30-foot-diameter antenna like this one at the NASA/Goddard Space Flight Center, Greenbelt, Md. (PN–2813).

scanner-measured reflectance of crops and soils has operational potential for distinguishing various kinds of vegetation.

In other experiments, scientists will be studying the detection of insect infestations on a variety of crop plants. Insect surveys from satellites could eventually replace or supplement many of the laborious, time-consuming, and expensive searches on the ground. Earlier detection afforded by satellites would enable the farmer to spray only limited areas, reducing environmental influences, and aiding the implementation and effectiveness of control measures.

Remote sensing from aircraft is being used operationally by USDA's Animal and Plant Health Inspection Service to detect citrus blackfly infestations (see p. 8). Hopefully, future remote sensing application may be done more efficiently and less expensively using satellites.

Studies on wind erosion of soils will be conducted by ARS agricultural engineer Donald W. Fryrear in cooperation with the Texas Agricultural Experiment Station, Big Springs. He will locate and monitor wind erosion problem areas and study the effectiveness of control measures, using high altitude aerial and space photography.

ARS hydrology engineer Bruce J. Blanchard at Chickasha, Okla., will study use of space data in watershed hydrology. Using photographic and scanner data, he will attempt to locate potential water supplies and identify erosion-prone areas.

No one can accurately assess the value of remote sensing for world agriculture. It is estimated that in the United States alone, fire, insects, and disease cause $13 to $20 billion in losses annually. Early detection of these enemies could provide for more timely application of effective control measures and thereby reduce the magnitude of losses. ☐

Above: *Delta 89 blasts off. (PN–2814).* ***Below:*** *The data processing facility at the Goddard Space Flight Center has the capability of handling 10,000 black and white and color images weekly. Copies of all ERTS–1 photographic images will go to the Department of Interior's Earth Resources Data Center, Sioux Falls, S. Dak., the U.S. Department of Agriculture, Wash., D.C., and the National Oceanic and Atmospheric Administration, Suitland, Md., in addition to over 300 approved investigators (PN–2815).*

This Finnsheep ewe may not be able to nurse both lambs. However, the lambs will be saved by the use of the new MARC nurser (0772X967–30).

Replacing mother's milk

ORPHANED or extra lambs can be successfully raised with a newly developed nurser.

The MARC lamb nurser, named for the U.S. Meat Animal Research Center, Clay Center, Nebr., where it was developed, can be built for about $70 and can handle 50 lambs. It is the first dispenser designed specifically for lambs. Those designed for calves are too expensive for lamb use.

The annual loss of lambs from starvation in the first 10 days after birth is estimated at 10 percent of the Nation's lamb crop. This statistic, with its economic implications, shows the urgent need for developing a means of artificially raising and feeding newborn lambs.

Many factors may create a need for artificially nursing newborn lambs. The ewe may have died, may have more lambs than she can care for, or may have a bad udder on one or both sides. A newborn lamb may be weak or, if there is more than a 2-pound difference in the birth weight of twins, the lighter lamb will likely starve or not grow at an adequate rate.

The MARC nursing unit is made from an insulated thermos lunch box to which are attached four lamb nipples. Milk replacer is conducted from large bottles held in a refrigerator through tubing into the nursing unit. At the Center an old refrigerator is used to service two side-by-side pens, with a nursing unit in each pen to handle 25 lambs.

Scientists working on the unit have also developed a milk formula to be fed with the nurser. High death loss in lambs has been reported when they were raised on calf milk replacers because of the differences between cow's milk and ewe's milk.

Recommendations for lamb milk replacer are: at least 30 percent fat and less than 30 percent lactose in the milk replacer powder; 24 percent milk protein in the powder; and milk replacer chilled to 40°F. at 20 percent dry matter concentration. □

Managing the soil for Protein

WHEAT PRODUCERS in the Central Great Plains need not forfeit acceptable grain protein levels in order to maintain maximum yields.

Studies by ARS soil scientists Darryl E. Smika, North Platte, Nebr., and Wally Greb, Akron, Colo., indicate that protein levels of 13 percent or higher are possible when yields average 30 to 50 or more bushels per acre.

Grain protein levels below the 11.5 percent minimum acceptable for milling bread flour have been reported in western Kansas and western Nebraska, but there have been conflicting reports on the causes. In some studies, protein content declined as yield increased, while higher yield was not accompanied by lower protein in other studies.

Protein is the principal nitrogen-containing constituent in the wheat kernel. Soil and climatic factors affecting the nitrogen nutrition of the wheat plant will therefore produce differences in the protein content of the grain. Dr. Smika and Mr. Greb studied the major soil and climatic influences on grain protein using data from 48 crop years at North Platte, Akron, and southwestern Nebraska locations.

They identified two positive and two negative influences on grain protein levels:

- Protein increased 0.13 percent for each pound of nitrate nitrogen per acre at the 4- to 6-inch depth in the soil at seeding time.
- Protein increased with maximum air temperatures up to 90°F. during the 15th to 20th day before maturity but declined with higher temperature during this 5-day period.
- Protein decreased 0.45 to 0.75 percent for each increase of 1 inch in available soil water at seeding time.
- Protein decreased 1.5 percent for each 1.0 inch of rainfall received the 55th to 40th day before grain maturity.

The combined influence of any two of the four factors—soil nitrogen, maximum air temperature, soil water, and rainfall—more accurately predicted protein content than did any one alone, and use of all four gave the closest statistical relationship to protein levels.

Wheat producers, of course, cannot control rainfall or temperature during the growing season, but they can influence soil water and soil nitrogen available at seeding time by management practices. The combined influence of these factors produced a reasonably accurate prediction of grain protein content at all levels studied.

The scientists found that 11 inches of soil water and 95 pounds of nitrate nitrogen per acre would have been needed to produce grain with 12 percent protein at the highest yield—58 bushels per acre. They point out that this soil water level can be obtained in most years on the Central Great Plains with good stubble-mulch fallow practices. Nitrogen fertilizer, in amounts balanced according to available soil water, may frequently be needed.

The studies also help explain the conflicting relationships between nitrate levels and yield reported by other investigators. Available nitrogen limited both protein content and yield when grain protein levels were between 9 and 11.5 percent. Protein levels greater than 12 percent were obtained with higher amounts of available nitrogen and smaller amounts of soil water. Thus, limiting water affected only yield, but limiting nitrogen influenced both yield and protein in the grain.

The researchers say there is no reason why yields higher than the maximum 58 bushels per acre in the study, along with grain protein of 13 percent or more, cannot be obtained when both soil water and nitrogen are manipulated by management. □

*Below: Poring over color infrared photographs taken over Mexico, ARS entomologist William G. Hart points out orchards heavily infested with citrus blackfly for APHIS assistant district supervisor, Robert Hardman. Trees infested with citrus blackfly can be detected from altitudes up to 10,000 feet. (0772X980-1). **Right:** ARS technician Moeses Garza observes honeydew excreted onto a leaf by the larvae of citrus blackfly. Fungi developed on the honeydew and formed a dense black coating. The coating obstructs light and air needed for photosynthesis and respiration (0772X977-7). **Far right, top:** Blackfly larvae cling to the underside of citrus leaf (0772X982-24). **Far right, bottom:** In the Mexican border town of Reynosa, a technician sprays fruit trees against citrus blackfly. The Mexican government and USDA's Animal and Plant Health Inspection Service have cooperatively fought the pest since an infestation was spotted there in mid-1972 (0772X976-30).*

Remote sensing vs Citrus Pests

A revolutionary technology, remote sensing, is being put into action against some of man's oldest enemies, insects. Citrus blackfly, a particularly destructive insect is already confronted by remote sensing. An ARS scientist who is developing this innovation further, is also enhancing its usefulness in cooperation with other U.S. and Mexican government agencies.

Not all uses of remote sensing in entomology are experimental. ARS entomologist William G. Hart, and his associates, developed a commercially feasible technique for early detection of brown soft scale and citrus blackfly using aerial color infrared photography. Infrared color photos taken from aircraft reveal blackened foliage where honeydew excreted by the insects caused sooty mold deposits to develop. This method of survey results in earlier detection of infested areas.

As more knowledge is gained about climatological, geographical and other environmental influences on insects, management of control measures may be enhanced. The greatest stress from chemical and biological controls could be applied in areas most vulnerable to further spread of destructive pests.

As a result of cooperative studies with the Fruit Insects Laboratory (ARS) at Weslaco, USDA's Animal and Plant Health Inspection Service (APHIS) recently started using remote sensing in its citrus blackfly control program. An estimated 63 percent reduction in the cost of surveys to detect infestation buildup can be realized using this technique rather than ground surveys alone.

At present, only trees with about 1,500 or more affected leaves (medium to heavy infestations), can be detected by remote sensing, and finding beginning or early infestations does not appear possible. As photointerpretation methods are improved and more studies are done on reflectance characteristics of affected trees, it may become possible to detect lower levels of infestations.

When infestations of citrus blackfly or other insects are found and sprayed, populations of the insects' parasites decrease. Remote sensing, which provides more rapid, less expensive insect detection than conventional methods, can enable the grower to spot-spray while the infestation is confined to a limited area. As remote sensing technology de-

Left: *Mexican technician collects parasites of citrus blackfly. Each technician collects a daily average of 3,000 of the sub-miniature wasps for release in other infested orchards. Researchers estimate that about 2 percent of the parasites are captured in any given area (0772X977-22).* ***Below:*** *Color infrared photographs—translated into survey maps—pinpoint medium and heavy infestations of citrus blackfly. Here, Roberto Barrietos of Mexico's Defensa Agricola talks over prospective parasite release locations with aerial photographer Sammy Ingles (left) entomologist William G. Hart, and APHIS representative Alberto Suarez. (0772X982-18).*

velops further and entomologists learn more about citrus blackflies and their parasites, greater effectiveness from integrated biological-chemical programs can be expected.

Integrated controls are presently used against citrus blackflies in the commercial citrus area near Monterrey in northeastern Mexico. Mexican and the United States government employees collect parasites of the insect and release them in areas where they are not firmly established.

One of the parasites, a tiny wasp named *Prospaltella opulenta,* is known to infest up to 85 percent of some citrus blackfly populations. The parasite lays its eggs in the citrus blackfly's digestive tract. After the eggs hatch the citrus blackfly inevitably dies.

To better exploit parasites, more knowledge is needed about the ecology of these allies and their citrus blackfly hosts. The parasites are not native to Mexico. The United States and Mexican Departments of Agriculture introduced several kinds from the West Indies as early as the late 1930's. The most effective species, *P. opulenta, Amitus hesperidum* and *P. clypealis* were brought to Mexico from India in 1950. Of some 200 of the citrus blackfly's hosts, scientists believe Mexican lime is the insect's favorite.

The Mexican Government's agricultural research agency has made a laboratory building and greenhouse available to ARS for a 2-year study on mass-rearing techniques for the citrus blackfly and its parasites. The new laboratory will be managed as a satellite of the Fruit Insects Research Laboratory at Weslaco, Tex. □

Citrus blackfly larvae cause some damage to citrus trees by feeding on leaves but their greatest damage comes indirectly. A sooty-mold fungus develops on honeydew excreted by the developing insect. When these sooty-mold deposits become heavy, they reduce the tree's photosynthesis and respiration. Heavy infestations lasting longer than a year may cause a complete crop failure. Infestations of shorter duration may reduce fruit production by 50 percent or more.

The insects invaded the Florida Keys in 1934 and were eradicated 3 years later. In 1955, they entered Texas and were eradicated in 1 year. Following another Texas infestation in April 1971, the citrus blackfly is still occasionally spotted in the Brownsville area.

APHIS and the Texas Dept. of Agriculture keep the Brownsville area under quarantine and, in cooperation with the Mexican Government, maintain an eradication zone extending from the Rio Grande River some 100–150 miles south to a major citrus-producing area. Susceptible plants and trees are sprayed with dimethoate, a nonpersistent chemical that is not toxic to birds, wildlife, or humans.

Twilight of the noctuids

Six new pathogens have been isolated that show potential in efforts toward nonchemical insect control. These isolations are the work of an ARS-sponsored Polish project concerned with the control of the Noctuidae, a large family of moths, many of whose larvae are destructive pests of important crops.

Dr. Arthur M. Heimpel, ARS-cooperating scientist, Beltsville, Md., says the principal investigator, Dr. Jerzy J. Lipa, and his colleagues concentrated their research on Polish insects related to two of the most destructive Noctuidae in North America, cutworm species and the corn earworm complex.

The Polish isolates include: a new cytoplasmic polyhedrosis virus (CPV), a nuclear polyhedrosis virus (NPV)—*Baculovirus agrotidis* Lipa, and three species of granulosis virus (*Baculovirus* spp.). All, in varying degrees, can infect certain species of the corn earworm complex, and the latter two disease types, *B. agrotidis* and *Baculovirus* spp., are infectious to cutworms.

In addition to the viruses, a microsporidium, *Plistophora noctuidae*, that is pathogenic to both cutworms and the corn earworm complex was isolated by Dr. Lipa. Microsporidia are an order of protozoans that survive in the environment by forming spores. Dr. Lipa found that when noctuid larvae were infected simultaneously with the microsporidia, NPV, and/or CPV, results were better than when each pathogen was applied individually.

Dr. Heimpel says that although this principle of integrated biological control has been demonstrated before, the Polish research represents the first case in which the microorganisms are still available and, in some instances, "in our hands."

The disease caused by NPV attacks the nuclei of the infected host cells. By contrast, the only host tissue involved in the CPV infection is the midgut epithelium. In granulosis infections, the nuclei of several larval tissues are infected. The isolated microsporidia proved exceptionally suitable for integrated biological control because they infect the midgut epithelium only. They aid the viruses to invade but do not compete with them for the same tissues.

Possibly the most promising of the six new pathogens is the NPV, *B. agrotidis*. Dr. Heimpel says the possibility of developing this NPV into a commercial product is under investigation. *B. agrotidis*, a deoxyribonucleic acid (DNA) virus is a multiple embedded virus that may be of considerable value to U.S. agriculture since it appears to have a wide spectrum of hosts. Also, DNA viruses generally tend to be more lethal than ribonucleic acid (RNA) viruses. The nucleus is the information center of a cell, and DNA is a characteristic nuclear constituent; the bulk of RNA is confined to the cytoplasm.

This Polish project was conducted under the provisions of Public Law 480 by the Institute of Plant Protection, Poznan. □

Nuclear polyhedrosis virus (NPV). When ultra thin sections of diseased cells are examined in an electron microscope one can see first the formation of single virus rods. Later (as shown here) the virus bundles and whole polyhedral bodies are formed with the consequent bursting of the host nuclei. The larvae become flaccid and upon death, the internal tissues (particularly the fatty tissue and hypodermis) disintegrate giving the body contents a fluid consistency. This photo shows 13–14 virus bundles enlarged 74,175 times(PN–2816).

Breaking the sales jam

A mechanized system for removing sheets of untied tobacco from the warehouse sales floor after an auction can cut costs almost 50 percent.

During the past decade, lifting sheets of tobacco onto hand trucks or jacks—square frames with casters under each corner—for transport from the auction floor to company load-out areas has been performed manually. Meanwhile, workers willing to do this task have become increasingly scarce.

A typical two-man team, part of a crew of 18 to 20 hired by a tobacco moving contractor to follow a sale, wanders about the warehouse, each with a jack for one processing company in one hand, and a jack for a different company in the other. They look for tobacco tagged in the name of a purchaser corresponding to a jack one of them is carrying.

Once one sheet is placed on a jack, a search ensues for the second sheet belonging to the same purchaser for stacking on the first sheet. The result is a random distribution of tobacco moving contractor personnel on the auction floor.

These conditions make it difficult to schedule growers' arrivals at the warehouse. Growers bring in more tobacco than the auction crew can handle quickly because the warehouse sales floor has not been cleared of the previous sale. Consequently, a logjam of idle trucks, manned by anxious growers, waits beyond the warehouse receiving doors for a chance to enter.

ARS industrial engineer Albert H. Graves and technician Kenneth R. Forrest, Raleigh, N.C., designed, built, and tested a system over the 1971 tobacco marketing season to help companies remove tobacco from the sales floor and reduce costs.

The researchers employed a standard 3,000-pound-capacity forklift in conjunction with two powered conveyors supported by a frame attached to the forks of the truck. This unit, which resembles a large "H" when viewed from overhead, is called a "sale breaker," and its function is to remove the sheets of untied flue-cured tobacco from the tobacco auction warehouse sales floor and transport the sheets to a jacking station. There, tobacco sheets are placed on a pair of inclined, gravity-roller conveyors, pulled to the conveyors, and stacked two high on purchasing company jacks.

Warehouse space is cleared away systematically and efficiently. The sale breaker moves into two rows of tobacco sheets with the conveyor belts tilted forward, permitting the moving belts to lift and roll under the sheets as the forklift advances.

Once the powered belts on the sale breaker transfer the sheets to the gravity conveyors, very little labor is required to guide the 200-pound sheet of tobacco down the conveyor and off onto a company jack corresponding to the purchaser of the tobacco sheet.

Two sheets are stacked on each jack. When consecutive sheets belong to different purchasers, the single sheets are loaded onto the proper company jack and moved aside until they can be matched with other sheets belonging to the same company, jacked two high, and moved to the load-out area.

Assuming that the tobacco moving contractor rents the forklift and buys the powered belt and gravity conveyors, the equipment cost for the sale breaker system is \$0.16 per 1,000 pounds of tobacco moved. Only seven men are needed to operate this system at a cost of \$0.23 per 1,000 pounds of tobacco, allowing a labor cost of \$2.00 per hour. The new system's cost thus totals \$0.39 per 1,000 pounds. This total is more than 50 percent under the current labor and equipment cost. □

Bottoms up for peanuts

Mr. Person and Dr. Pettit collect peanut samples from an inverted windrow (PN–2817).

PEANUTS dried in inverted windrows are generally less severely damaged by bacteria and fungi and contain a lower percentage of mycotoxins than those dried in random windrows during the curing process.

Windrow, an old haymaking term, refers to the rows of peanut plants with pods attached left in the field by the mechanical harvester. Some peanuts are left in the windrow for 2 or 3 days, after which they are combined and airing is completed in sacks in the same field or in bins or trailers with forced circulation of unheated or slightly heated air. Other peanuts are cured entirely in the windrow, requiring usually 5 to 10 days or 2 weeks, depending on weather conditions.

Some harvesting machines leave the peanut pods in a random arrangement within the windrow—some pods resting on the ground, some buried in the center of the row completely surrounded by other plants, and some near the top exposed to sun and air. An inverted windrow has all the pods exposed on top of the row, providing the opportunity for all to be drying simultaneously and thus insuring more uniform curing and higher yield of marketable peanuts.

Aspergillus flavus infested peanut kernels with spore masses (PN–2818).

Loss of peanut quality during windrow curing may not only lower yields but can cause the processed products to be less suitable for food and feed because of the lowered nutrient value and possible presence of mycotoxins.

With the aid of a research grant from ARS, plant pathologists Robert E. Pettit and Ruth Ann Taber and agricultural engineer Nat K. Person, all of the Texas Agricultural Experiment Station, College Station, studied the relationship of microbial infestation to windrow-curing methods.

Inverted windrows are a more generally successful drying method in terms of microbial damage. However, the scientists found that peanuts dried in inverted windrows during periods of low humidity, high winds, and high temperatures have more splits. Splits are the name given to the two peanut halves when they break apart. Splits tend to be more susceptible to disease organisms. Under slower drying conditions, however, inverted windrows are much superior.

The scientists also found that the most suitable method for drying peanuts is on the vine under cover, using forced natural air to maintain a slow, continuous drying. Unfortunately, this method is not economically sound. The second best, and an economically sound method, involves partial drying in inverted windrows followed by combining and forced air drying in bulk containers. □

Bolstering weak seedlings

PROTOTYPE autodibbles—punch planters—may lead the way to precision planting of crops with physically weak seedlings such as carrots, lettuce, onions, and sugar beets.

Weak seedlings may fail to emerge because of premature soil drying, accumulation of salts in shallow seedbeds, or from not being able to break through even mild soil crusts. Many times farmers overplant in order to get adequate stands and must then resort to time-consuming, expensive hand thinning.

Any precision planting method designed to rid farmers of these planting deficiencies must insure a consistently high emergence of seedlings under all microclimatic and soil conditions.

Machinist W. H. Heinemann, Jr., soil scientist J. W. Cary, and machinist A. E. Dilworth, all of ARS and based in Kimberly, Idaho, using Dr. Cary's punch planting studies (AGR. RES., July 1967, p. 5) designed and are now studying a pneumatic punch machine as well as a belt-type punch planter.

Dr. Cary found that seeds deposited on the bottom of holes germinated, sent up shoots, and took root without benefit of soil cover. Besides eliminating the crust problem, punch planting puts the seed deeper into the soil where it has access to more moisture during germination and early growth. Also, temperature of the seeds at the bottom of the holes is several degrees cooler than in normal seedbeds—an advantage in hot-weather areas such as the Southwest. The method also has the advantage of putting the seed below shallow salt accumulations.

The Kimberly pneumatic punch machine, taking into account the need for a stable surface and firm seedbed so that the holes don't fill with soil, uses a wide packing wheel to precede a punch that is attached to an air cylinder.

Magnets attached to the wheel actuate an electric switch that opens an air valve forcing the air cylinder and punch to poke a hole in the soil. Magnet spacing on the wheel determines seed spacing. As the punch enters the soil, it activates a seed dropper, which delivers a seed over the hole as the punch makes its return stroke with the aid of an internal spring in the air cylinder. Several adjustments on the planter allow for matching seed delivery time to tractor speed.

The seed dropper has a vertical rotating wheel with slots which hold one seed at a time. As the wheel rotates, single seeds are carried over the top against a nonrotating seed-retaining ring. That ring has an opening at the lower forward portion to deliver the seed to a spout, which in turn directs it into the hole in the soil.

The belt-type planter looks something like a small crawler-type tractor with a pair of sprocket wheels on each end supporting an endless belt. The belt is riveted to brackets brased to the sides of two chains, which in turn run on the sprockets. Soil punches are between the front pair of sprocket wheels, with the belt containing holes or eyelets spaced exactly the same distance as the punches.

The punches, mounted on shafts suspended between the sprocket wheels, can rotate through an arc of 120°. As the punch enters the soil, the eyelet in the belt holds it in position while the end of the punch rotates because of the movement of the wheel. The movement makes a slightly "bell-shaped" hole which should hold soil moisture longer than the "slot" shape produced by the pneumatic planter. As the punch rises out of the eyelet, a spring on its shaft returns into the proper position to engage with the next eyelet.

A single seed-drop mechanism similar to that described above is actuated by the punch carriers on the front wheel. A seed is dropped onto the belt as each punch is removed from the belt eyelet. The seed is then brushed into the hole which has remained over the hole in the seedbed. This unit, like the pneumatic planter, requires moist soil that can be packed into a firm, stable surface and seedbed. It can be mounted on a tow bar behind a strip-type incorporator and bed shaper.

Soil stability is a must in order for punch planting to be successful. If the hole fills with soil before the seedling emerges, the plant may not emerge. Having the soil moist on the surface and then compressing it with a packing wheel is the first step in forming a stable hole. However, rain may still cause holes to fill with soil.

For that reason the Kimberly researchers initiated a greenhouse study to test the feasibility of soil stabilizers. They found that polyvinyl chloride, Coherax, asphalt, and phosphoric acid all gave near-perfect emergence when applied to a convex surface consisting of a mound of soil about ½ inch high and 3 inches wide.

Additional development and testing in a variety of climates will continue because of the potential of punch-planting in establishing, under a wide range of conditions, a uniform, consistent, and precision planted small seeded row crop without hand labor. ☐

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